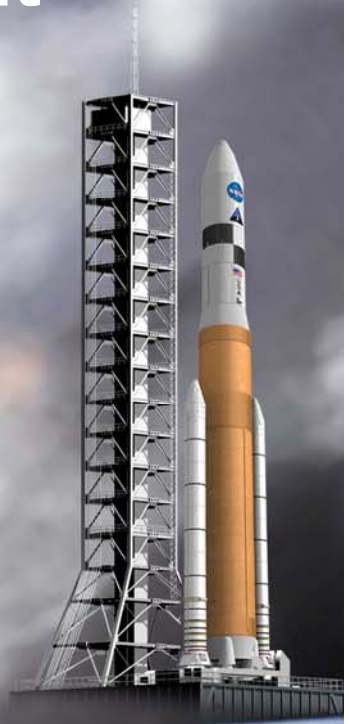
NASA'S MSFC Welding Development for *Ares I*



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NASA's MSFC Welding Development for *Ares* I Program

AGENDA

- Introduction
- Video of NASA's Constellation Program
- Vehicle Configuration
- MSFC Welding/Fabrication Capabilities
- Weld Tools for *Ares* I Fabrication/Welding
- Closing Remarks / Questions

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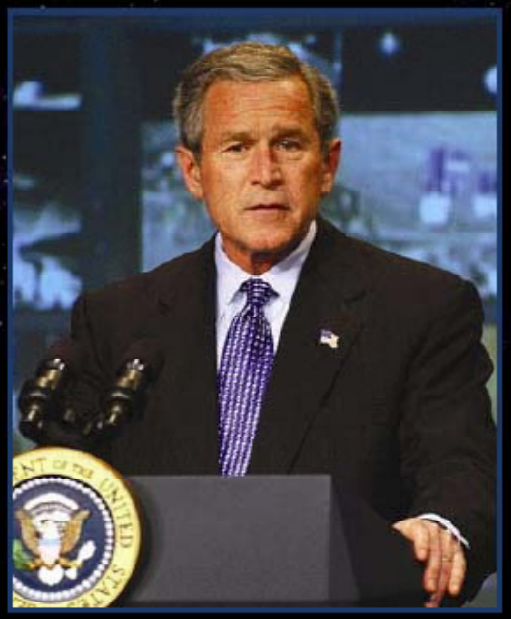
A Bold Vision for Space Exploration

- Complete the International Space Station
- Safely fly the Space Shuttle until 2010
- Develop and fly the Crew Exploration Vehicle no later than 2014
- Return to the Moon no later than 2020



NASA Authorization Act of 2005

"The Administrator shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations."

NASA's MSFC Welding Development for *Ares* I Program

INSERT MOVIE

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NASA's MSFC Welding Development for *Ares* I Program

Launch Abort System

Crew Exploration Vehicle (CEV)
(Crew Module / Service Module)

Spacecraft Adapter

Instrument Unit

Forward Skirt

Upper Stage

J-2X Upper Stage Engine

Interstage

Forward Frustum

First Stage
(5-Segment RSRB)

***Ares* I**

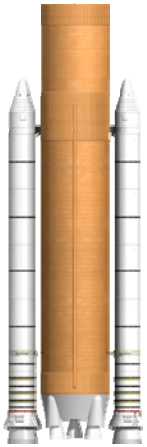
48k lbm to LEO

Composite Shroud

Lunar Surface Access Module (LSAM)

<u>Earth Departure Stage</u>
LOx/LH_2
1 J-2X Engine
Al-Li Tanks/Structures

Interstage



<u>Core Stage</u>
LOx/LH_2
5 RS-68 Engines
Al-Li Tanks/Structures

2
5-Segment
RSRB's

117k lbm to TLI
144k lbm to TLI in Dual-Launch Mode with *Ares* I
290k lbm to LEO

***Ares* V**

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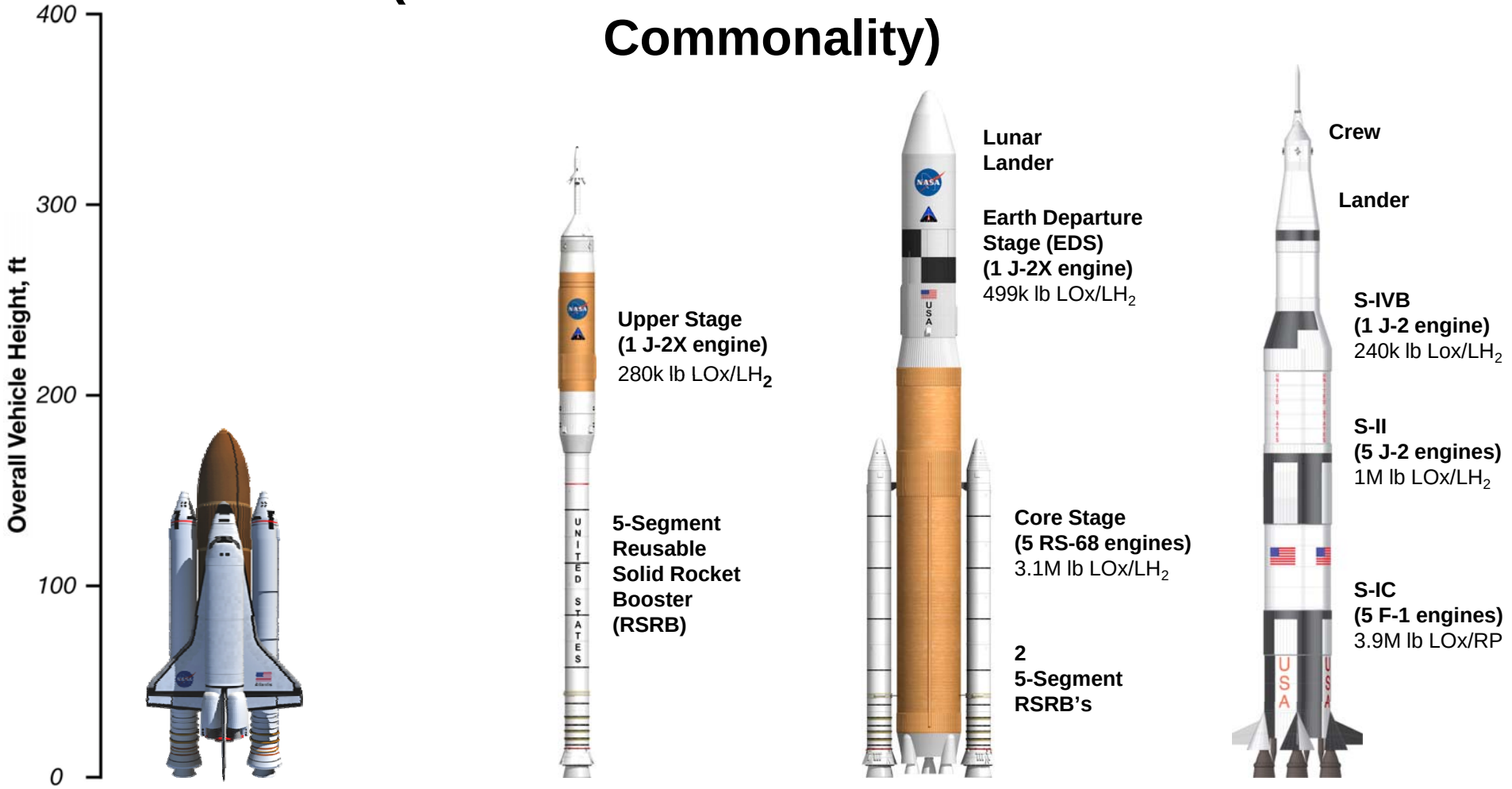
Launch Vehicles Comparisons (Blue Arrows Indicate Hardware Commonality)



Space Shuttle

Height: 184.2 ft
Gross Liftoff Mass: 4.5M lb

55k lbm to LEO

Ares I

Height: 321 ft
Gross Liftoff Mass: 2.0M lb

48k lbm to LEO

Ares V

Height: 358 ft
Gross Liftoff Mass: 7.3M lb

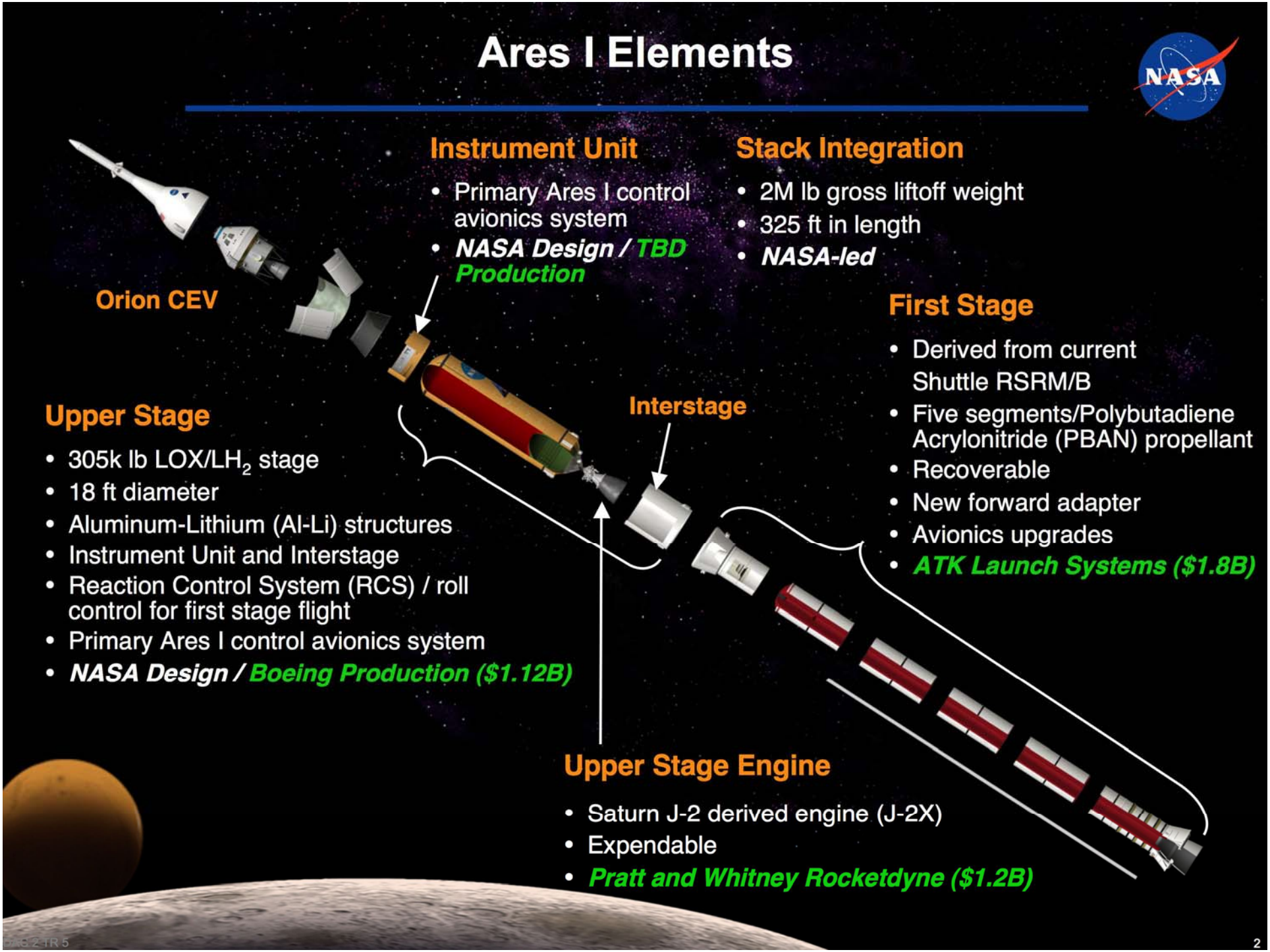
117k lbm to TLI
144k lbm to TLI in Dual-Launch Mode with *Ares* I
290k lbm to LEO

Saturn V

Height: 364 ft
Gross Liftoff Mass: 6.5M lb

99k lbm to TLI
262k lbm to LEO

Ares I Elements



Instrument Unit

- Primary Ares I control avionics system
- ***NASA Design / TBD Production***

Stack Integration

- 2M lb gross liftoff weight
- 325 ft in length
- ***NASA-led***

Orion CEV

Interstage

First Stage

- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitride (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ***ATK Launch Systems ($1.8B)***

Upper Stage

- 305k lb LOX/LH_2 stage
- 18 ft diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument Unit and Interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- ***NASA Design / Boeing Production ($1.12B)***

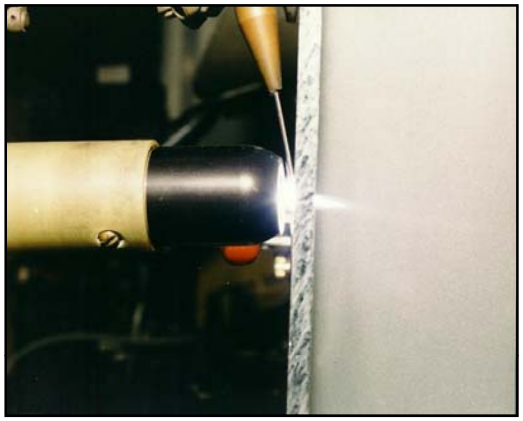
Upper Stage Engine

- Saturn J-2 derived engine (J-2X)
- Expendable
- ***Pratt and Whitney Rocketdyne ($1.2B)***

In-House Capabilities

- **Fusion Welding**
  - GTAW
  - PAW & VPPAW
  - GMAW, SMAW, etc…
- **Friction Stir Welding**
  - Conventional and Self Reacting
  - High Speed
- **Friction Plug Welding**
  - Push and Pull Plug Welding
- **Thermal Stir Welding**
- **Electron Beam Welding**
- **Thermal Spray Processing**
  - Vacuum Plasma Spray
  - Arc Spray
  - High Velocity Oxy Fuel Spray
- **Space Environment Simulation**
  - Space Welding
  - RCC and Tile repair
- **Machine Shop**
  - CNC Mills and Laths
  - Fabrication of Pin Tools, Fixtures, Test Rigs, etc.
  - Mechanical and Metallurgical test specimen prep

High Speed FSW



Plasma Welding

In-Space Simulation

Vacuum Plasma Spray

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WELD TOOLS SUPPORTING *ARES* I FABRICATION

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NASA's MSFC Welding Development for *Ares* I Program

GROUNDRULES FOR *ARES* I MANUFACTURING

- All technology must be TRL 6
- Self Reacting Friction Stir Welding is preferred process for making circumferential welds
- Plug Repair for Keyhole Closeout
- Conventional FSW is preferred process for making straight linear welds
- Common Bulkhead

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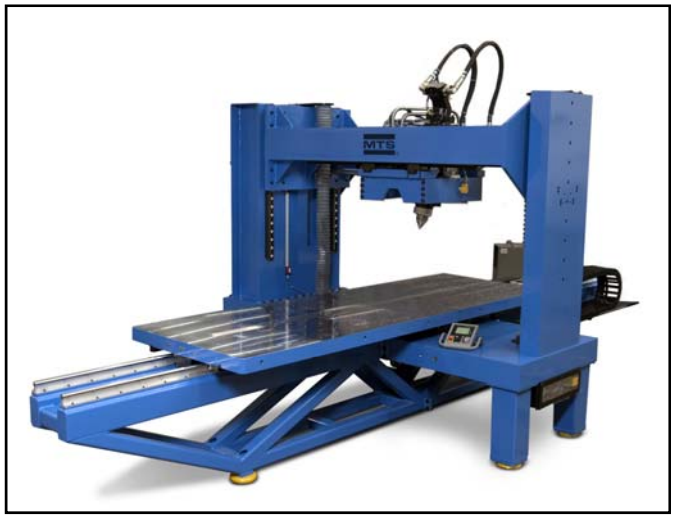
NASA's MSFC Welding Development for *Ares* I Program

MSFC Vertical Weld Tool used for ET Development
14 foot welds

Thermal Stir Welding (STW) System

- TSW, C-FSW, SR-FSW



Production Development System (PDS)

- 5 degrees of freedom
- Small but extremely capable machine that is ideal for development work.

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Universal Welding System (MAF)

External Tank Production
Conventional FSW only

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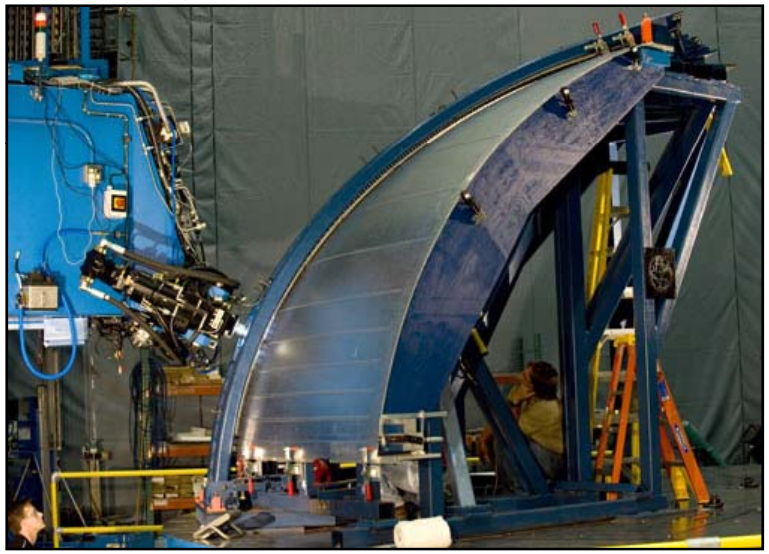
Robotic Weld Tool (RWT)



- 7 degrees of freedom
- Capable of circumferential and complex curvature welds in structures up to 36 feet in diameter.
- Max welding height is 22.5 feet. However, structures up to ~ 60 feet-tall can be supported on the table.

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NASA's MSFC Welding Development for *Ares* I Program

New MSFC Vertical Weld Tool capable of 25 foot long welds in barrels exceeding 40 feet in diameter

Vertical Weld

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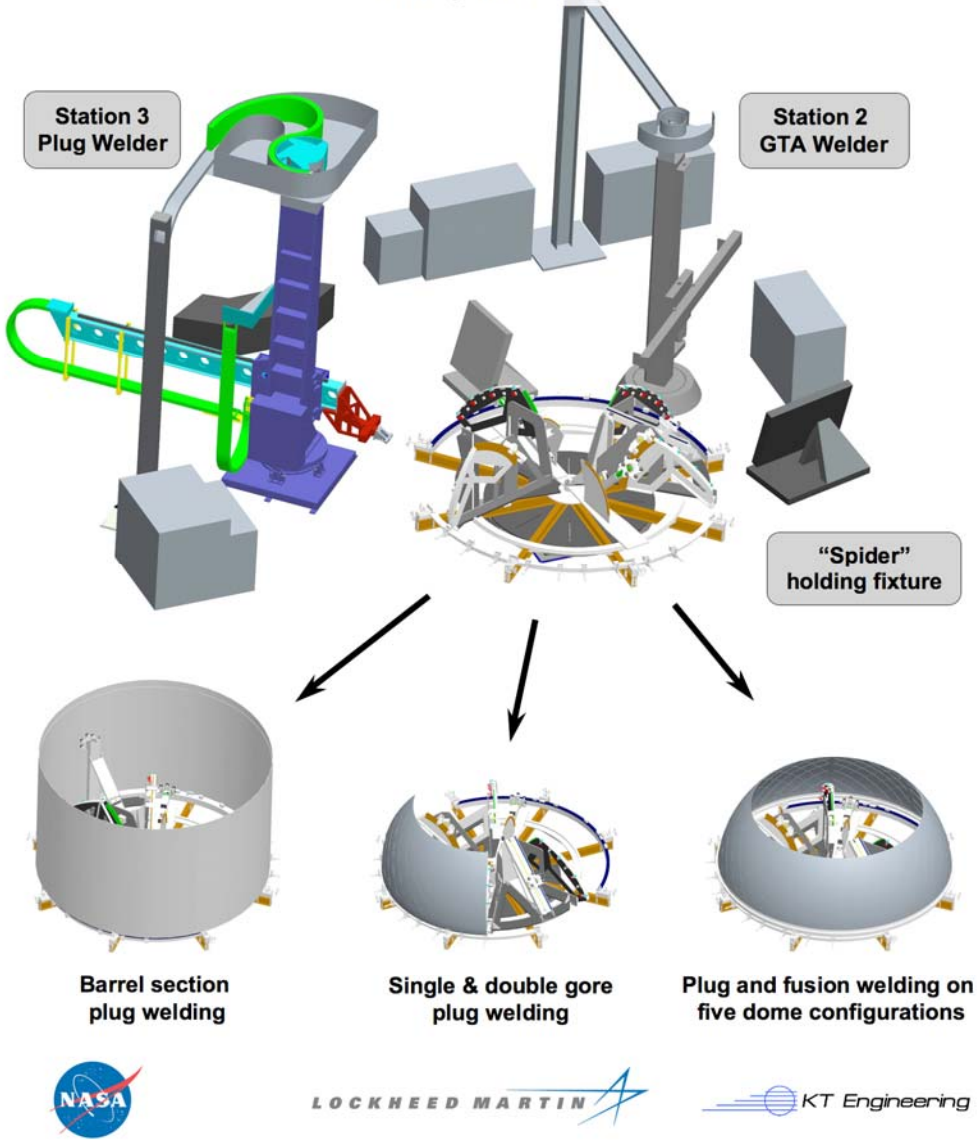
Dome/Gore Processing Station

Multi-purpose station for performing friction stir plug welds and GTA seam welds on Ares I upper stage gores, domes, and barrels



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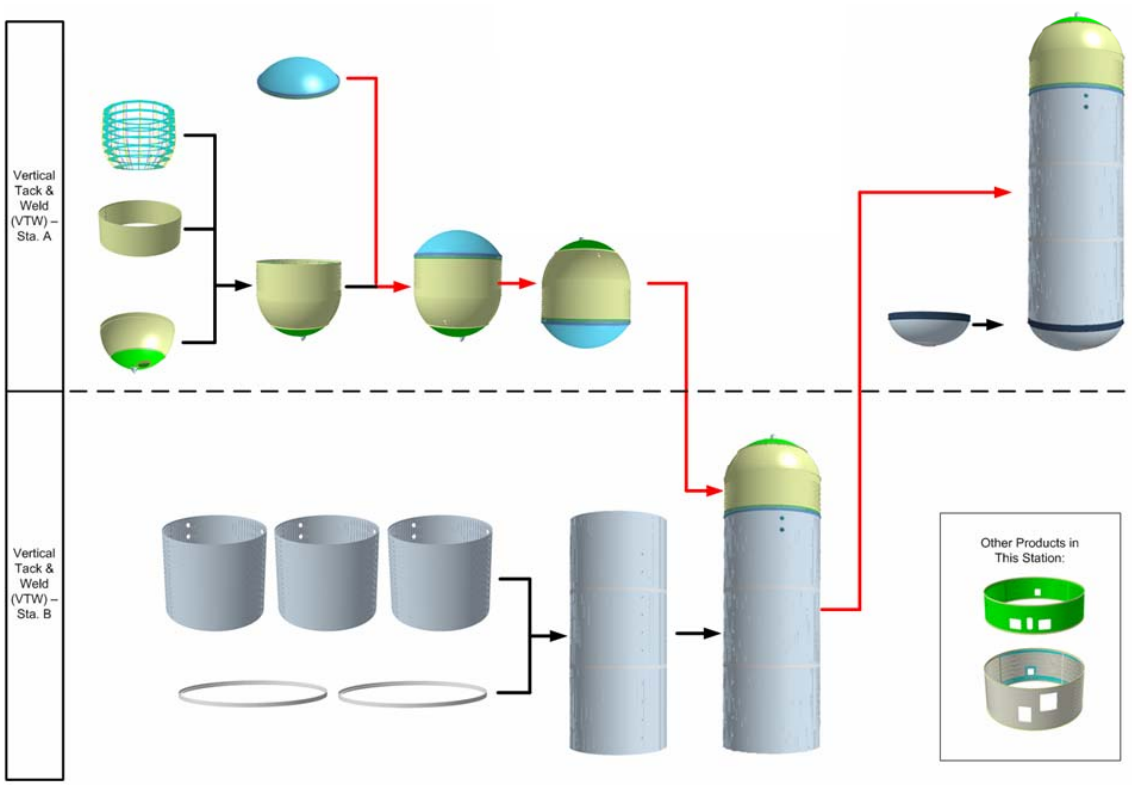
STACKING PROCESS FOR VERTICAL ASSEMBLY



NASA's MSFC Welding Development for *Ares* I Program

CLOSING REMARKS / QUESTIONS

- Prime contractors – selected for ARES I Prod.
- ARES I on schedule for flights beginning 2014
  - March: Orion 1 – unmanned
  - September: Orion 2 – manned
  - June 2015: Orion 3 - manned

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2014:

March: Orion 1
launcher: Ares I-3
launch site:
mission: unmanned test flight

September: Orion 2
launcher: Ares I-4
launch site:
mission: manned flight

2015:

June: Orion 3
launcher: Ares I-5
launch site:
mission: manned flight